Laboratory 3: Calibration, Odometry and Lidar Mapping

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April 7, 2023

1 Lidar Localization with AMCL Package

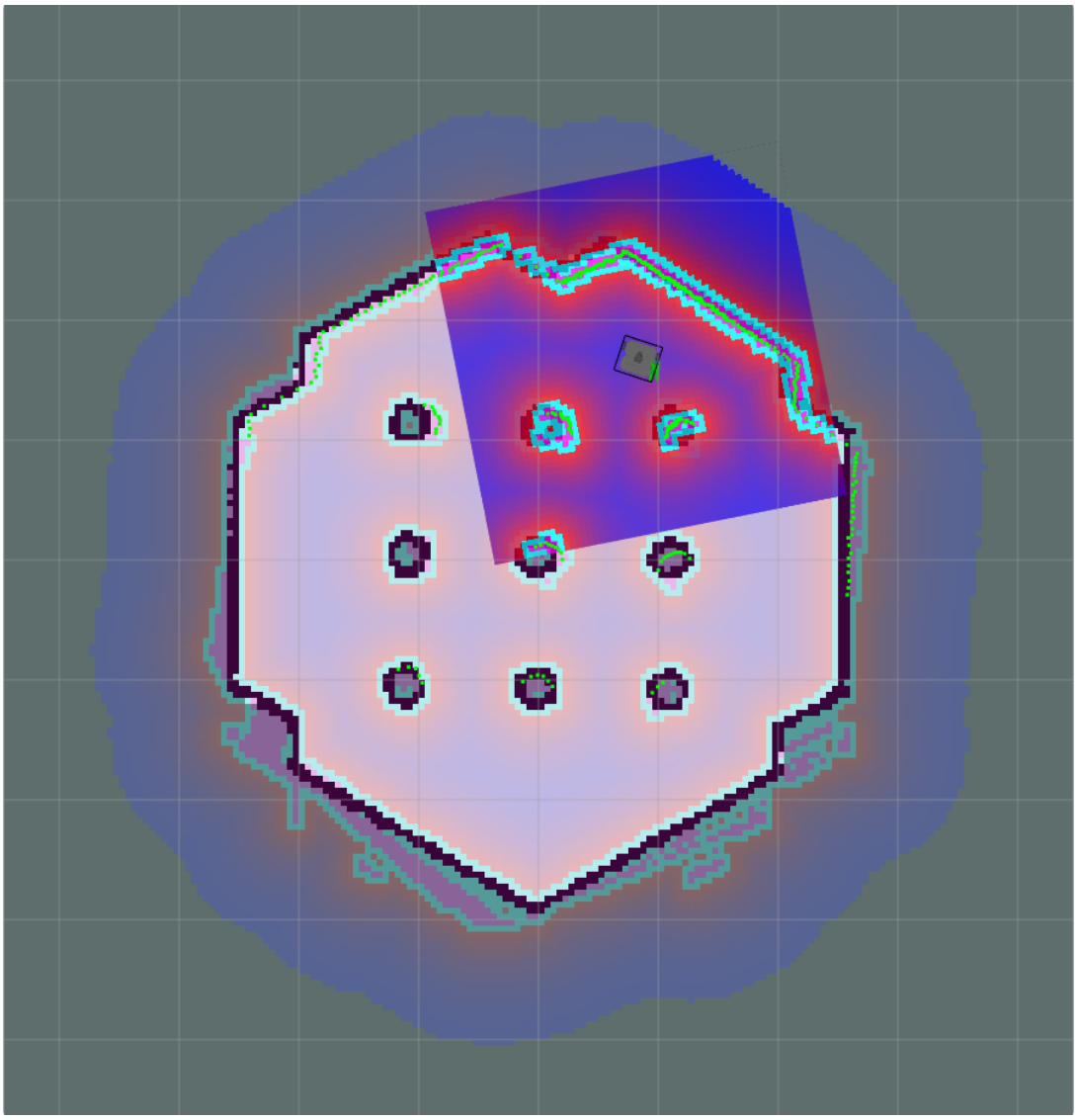

Figure 1: Motion estimation for circular motion.

The minimum values for the particle filter parameters required to yield successful localization are $min\_num\_particles = 7$ and $max\_num\_particles = 75$. A new pose estimate was provided for every iteration when the parameters were changed and conclusions were drawn after driving around most of the map, giving different setups the opportunity to converge - the results are also repeatable from run to run with slight differences in the time for convergence depending where we are on the map after the provided pose estimate. Using the same testing methodology, the maximum values for the *Odom Alpha* parameters are determined to be (3.75, 3.75, 3.75, 3.75, 7.5).

2 Mapping with Gmapping

The new map is significantly improved from the one obtained in lab 3 with respect to the "drift" of features which is observed over time, and when quick movements of the robot are made. As can be seen in lab 3, the obstacles on the top right and middle right have been localized in different positions due to drift in the dead reckoning. On the right however, we can see that none of the obstacles display this drift, even after a more extensive mapping of the region, noting how the back of the obstacles are mapped on the right while on the left, the backs remain unmapped as a shorter path was chosen due to the drift starting to come into effect.

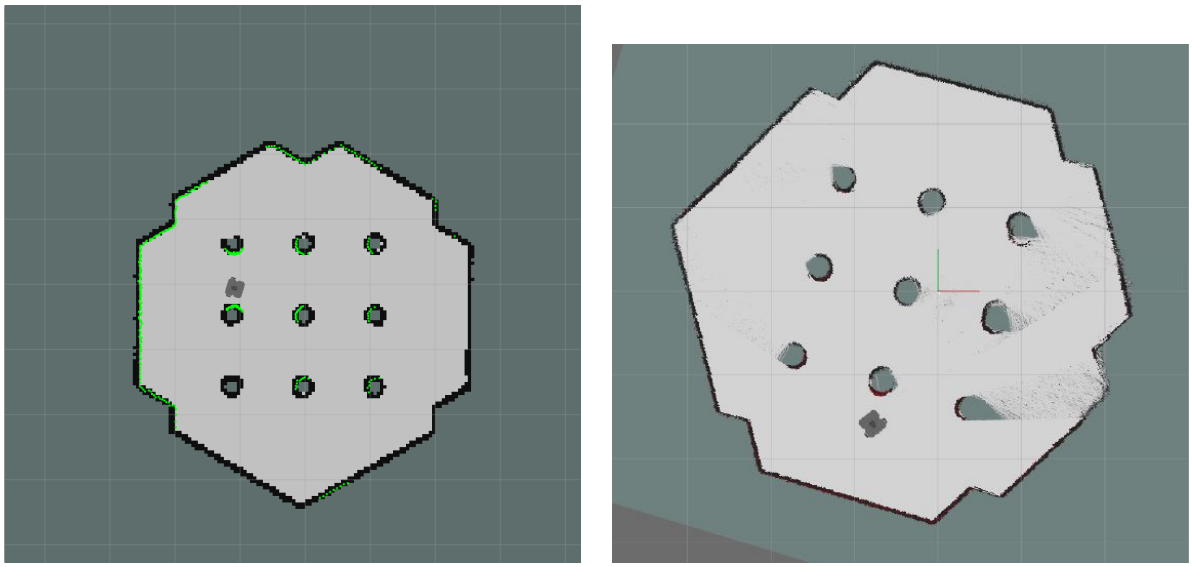

Figure 2: Gmmaping v. lab 3 mapping algorithm.

3 Willow Garage Mapping

Comparing the map (blue path) with the ground truth one from lab 2, we can see that the mapped result is fairly faithful to the real world. The scale of the map seems accurate, and all the major features (walls) appear in the correct locations. Some slight deviation can be seen in the upper left corner of the SLAM map, which seems to bend downwards slightly. This can be attributed to a longer straight corridor being mapped with no loop closure, so error is still allowed to accumulate slightly and cause minor drift artifacts. In Figure 5, where both loops are executed we can see that the blue portion of the path has been wrapped more inwards which is a readjustment of the map after completing the first loop and entering into an unmapped environment.

NOTE: We were not sure whether this part required 2 loop executed separately or one after another - an email was sent to the TAs but we never heard back. Our team gathered the data for the single blue loop and blue + purple loop path.

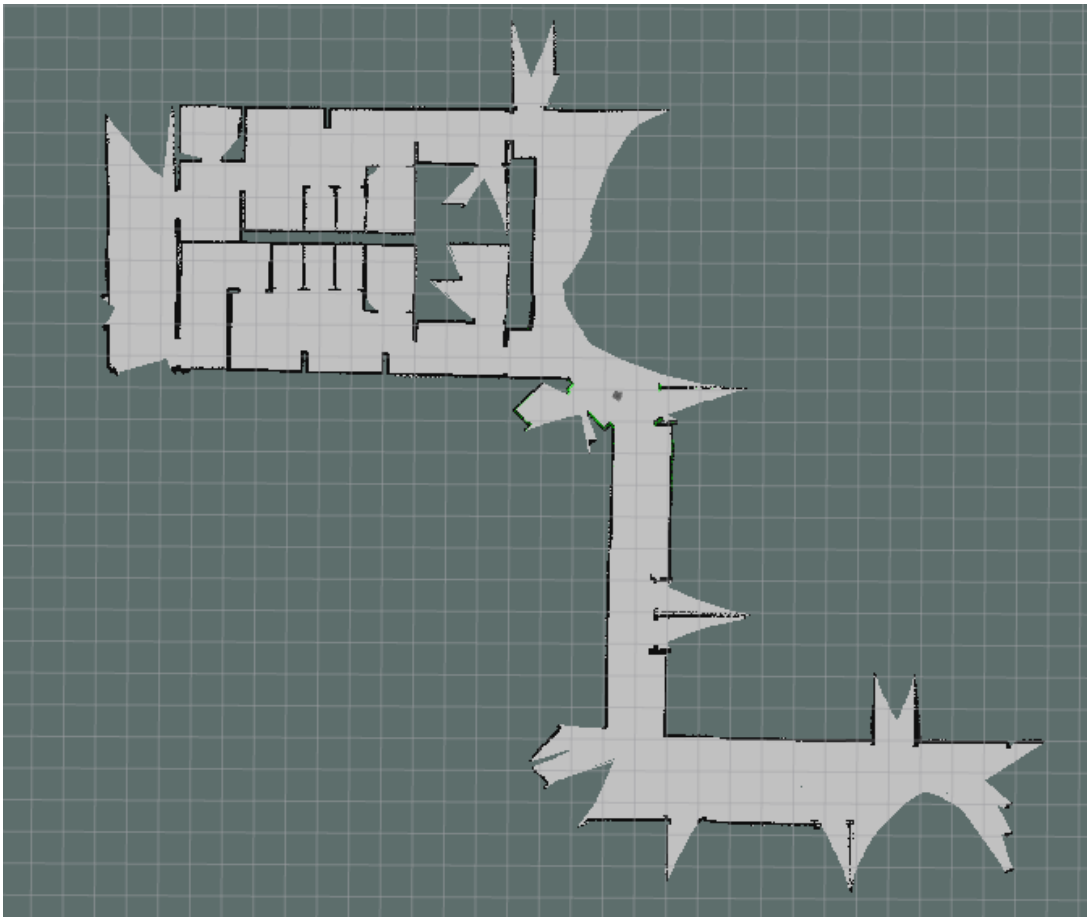

Figure 3: Blue loop only on Willow garage map.

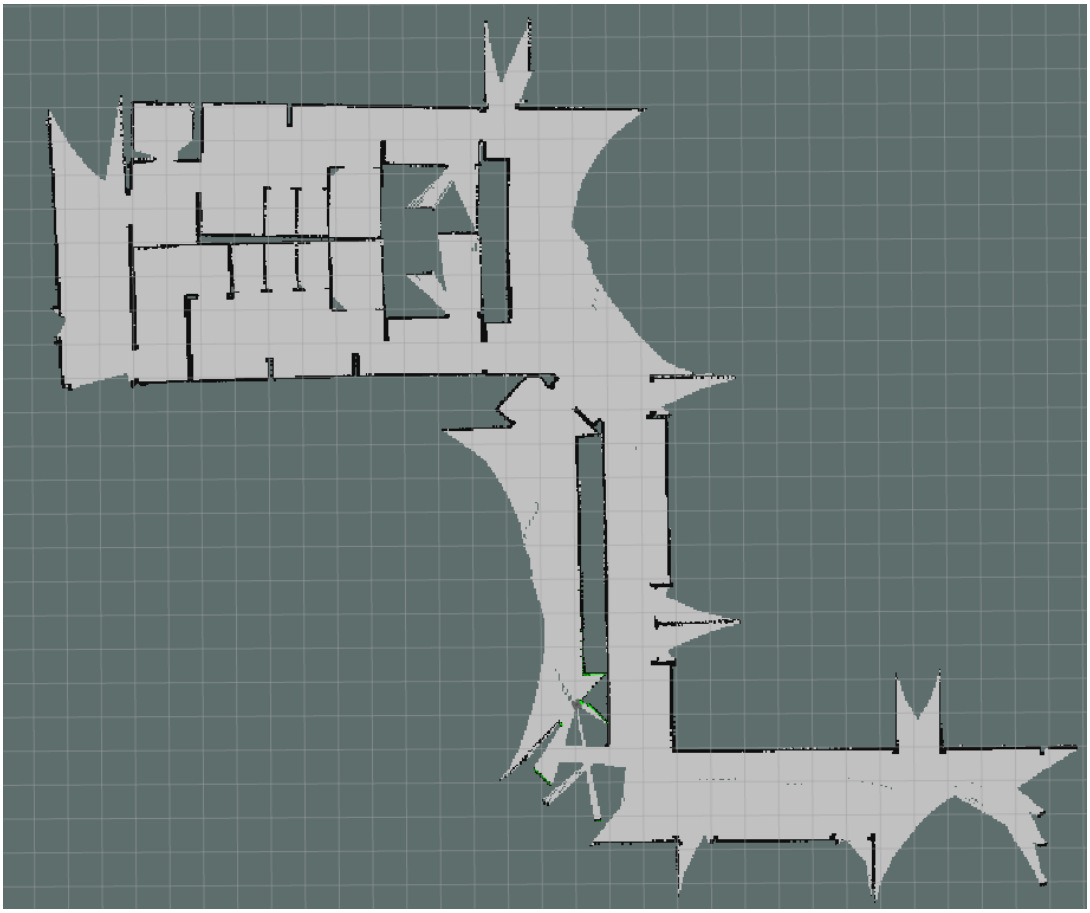

Figure 4: Blue and purple loop on Willow garage map.

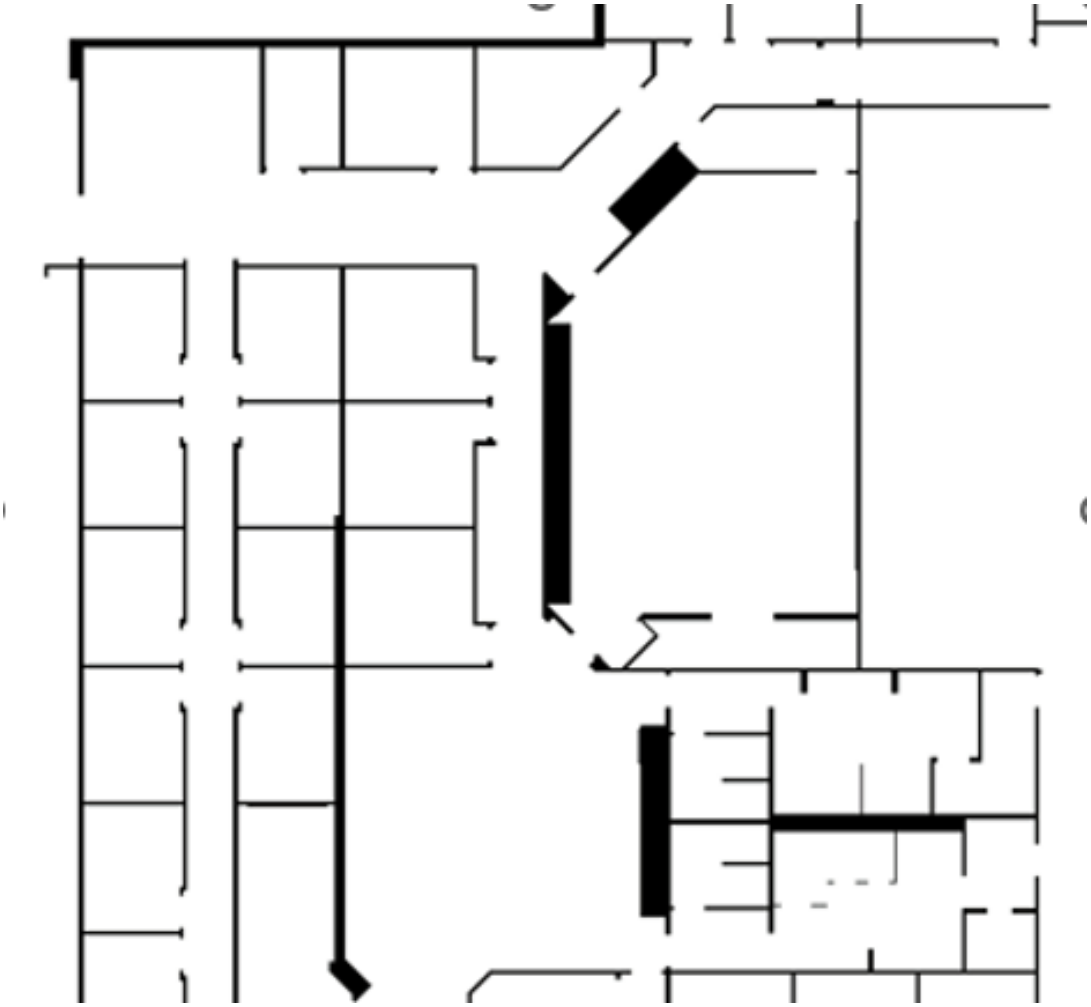

Figure 5: Ground truth of Willow garage map.

4 Myhal Environment Mapping

The map in constructed through the Gmapping algorithm resembles the layout of obstacles in the laboratory and their relative position and orientation with respect to one-another is accurate. One thing we noticed is that adjacent obstacles have gaps in between them and the readings might differ when the robot scans the section from different poses, which can be a significant source of error. On the same note as the aforementioned, the surrounding environment outside of the maze has objects that move dynamically, namely students and chairs moving around the maze - loop closures carried out during our mapping might have potentially failed due to the dynamic environment and gaps that are not observable from different perspectives within the maze. Another significant source of error would be the control inputs we used when mapping the maze at particular sections, for example turning fast around a corner. Moreover, the sensor noise and accuracy of the motion model used by the Gmapping algorithm can introduce additional error in mapping obstacles and estimating our robot's pose - the configuration parameters of the algorithm might need to be tweaked for applications on a physical robot.

Figure 6: Myhal mapped environment.

Figure 7: Myhal obstacle configuration.